

October 1996 Preliminary Data Summary

by Field Research Facility

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulics Laboratory's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at <http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Please note the new web address <http://www.frf.usace.army.mil>

Your comments and criticisms are welcome.

Introduction

1

The U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulic Laboratory's (CHL) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (*c.baron@cerc.wes.army.mil*).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

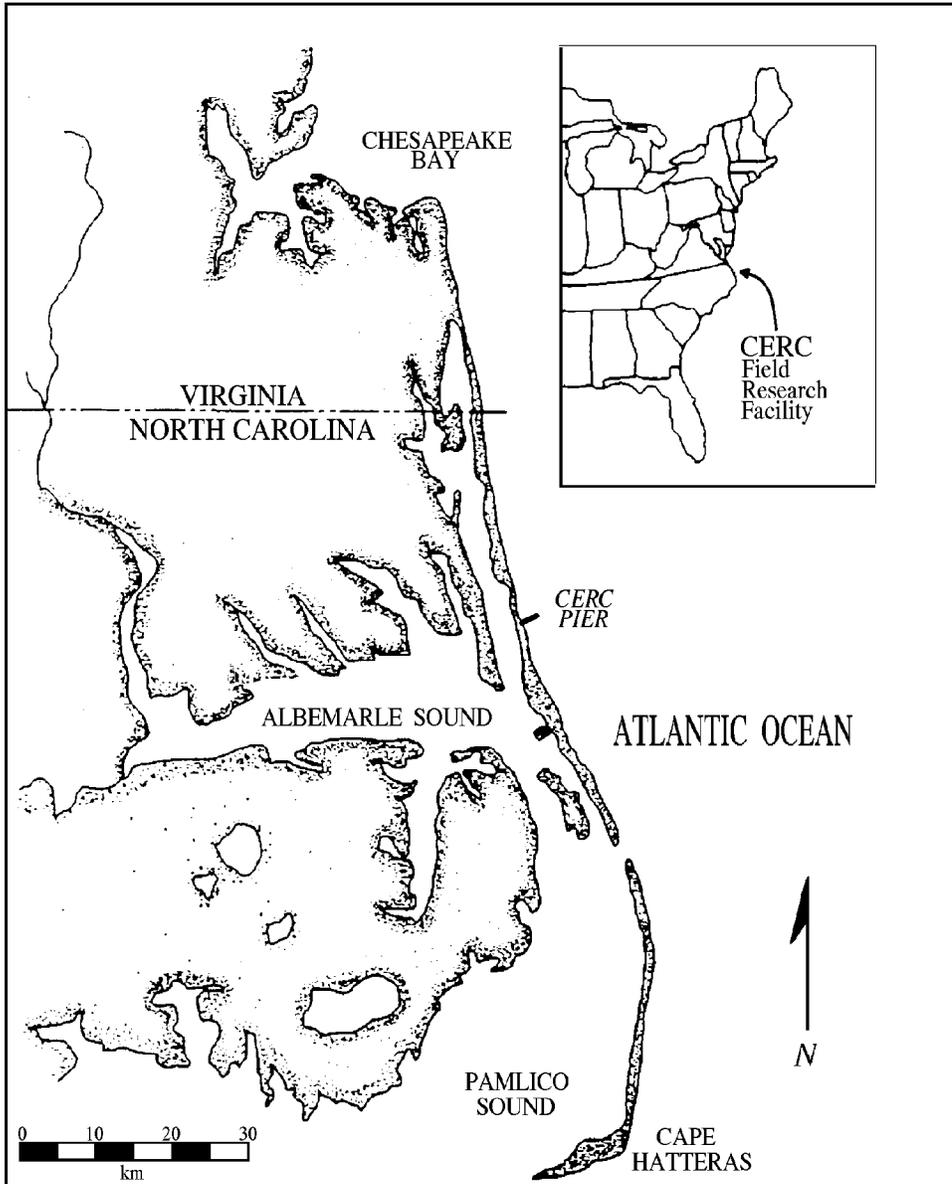


Figure 1. FRF Location Map

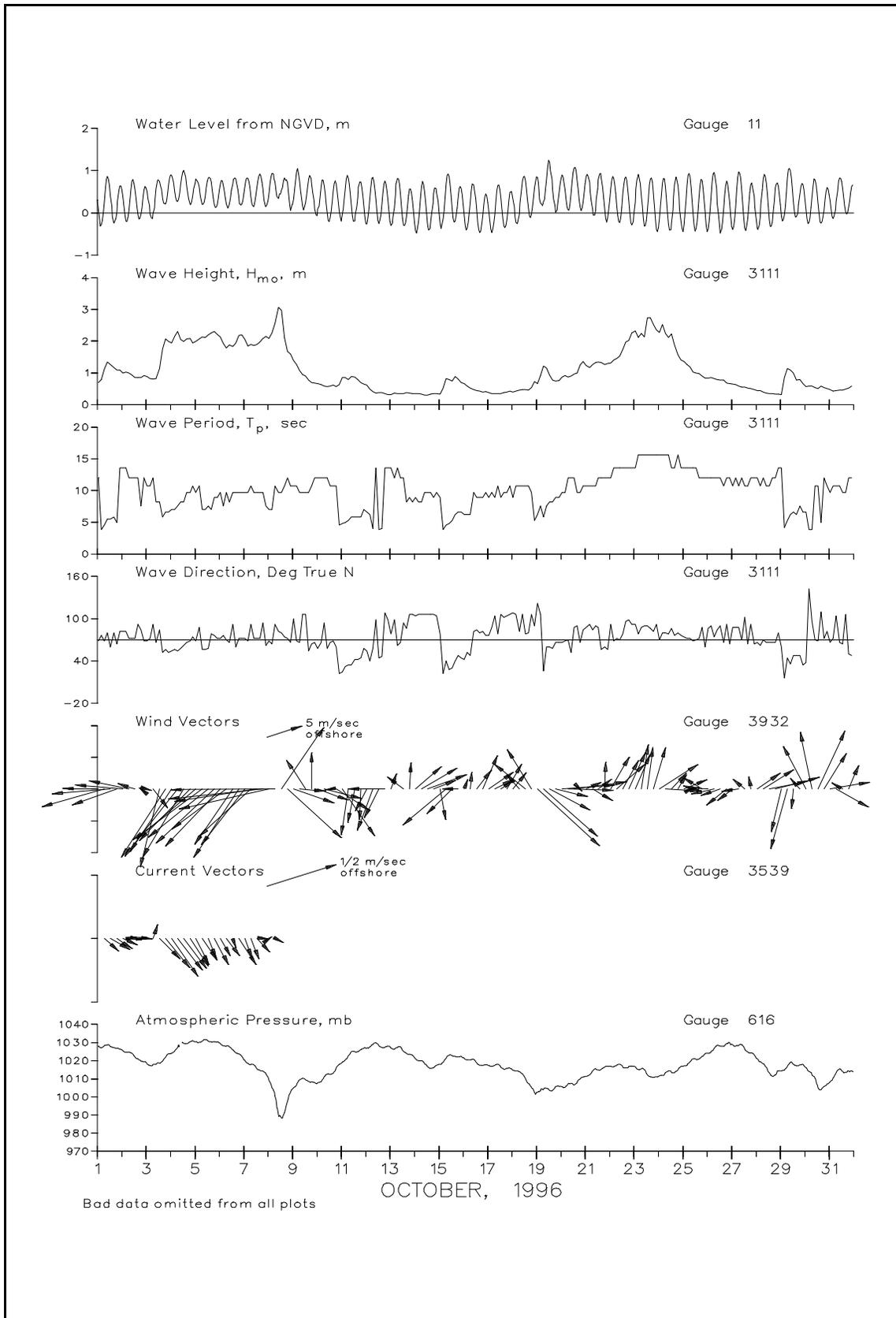


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

		October 1996																																		
		Day of the month																																		
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-				
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
		Data Collected	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-	-	/	-	-	-	-	-	-	-	-	-	-					
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
	Gauge Status		*	/	-																															
	Data Collected		*	/	-																															
	Visual Observations		*	/	-																															

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates *Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62
R	R	R	R	R	R	R	R

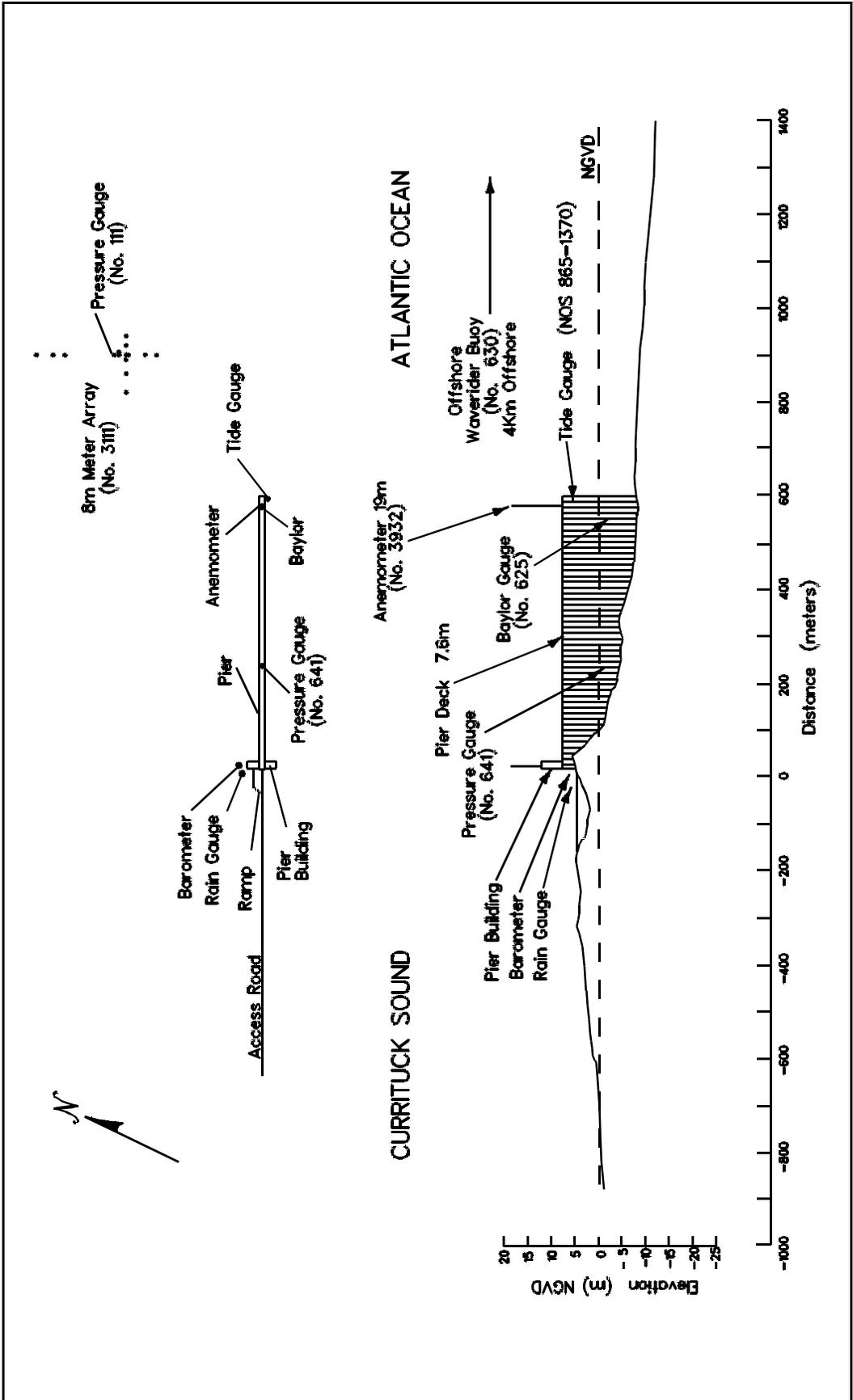


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

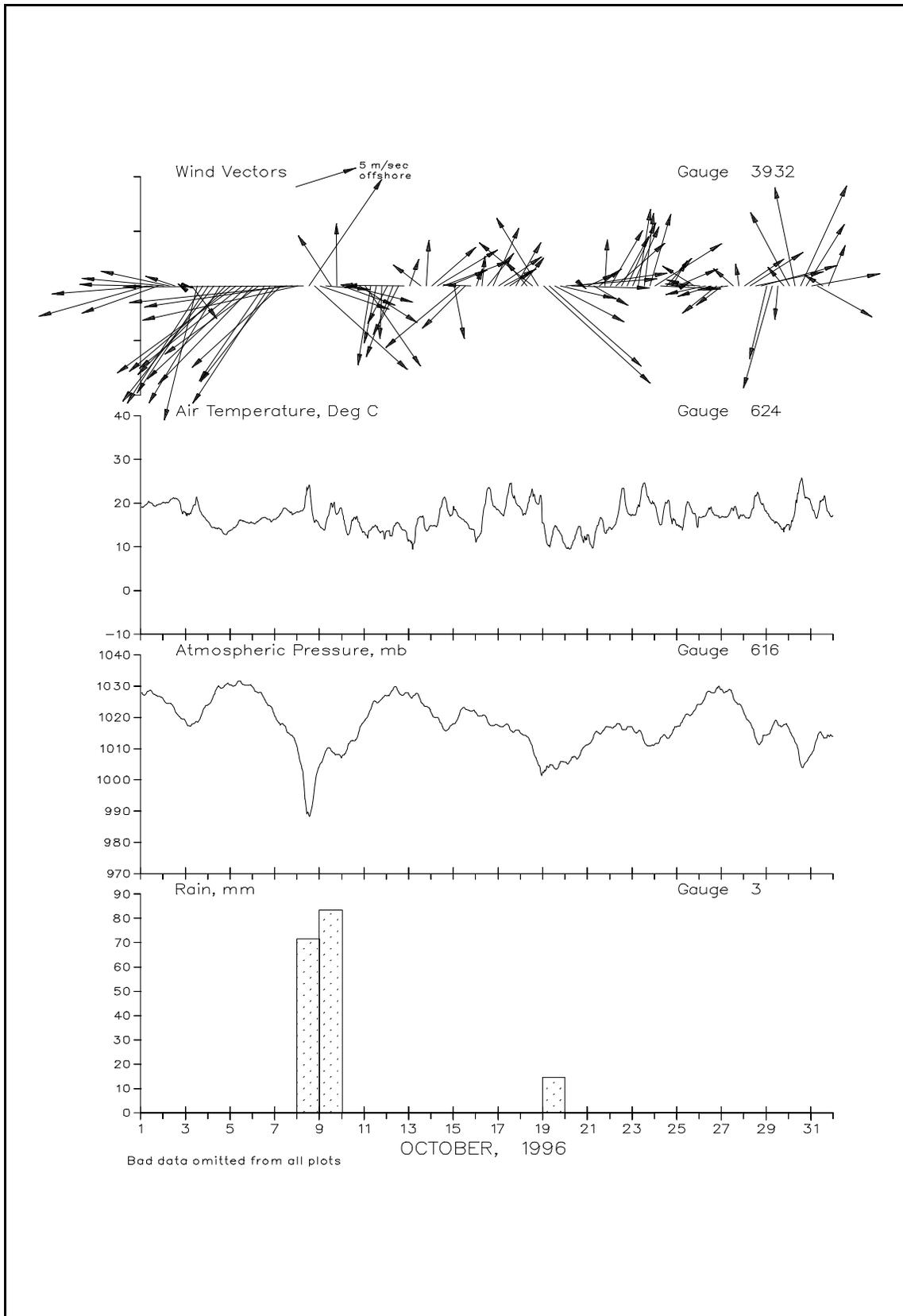


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Oct 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	5	91	19.1	1028.0	0
	700	9	71	19.9	1028.2	0
	1300	8	84	19.8	1027.7	0
	1900	7	67	19.6	1026.9	0
2	100	6	96	20.1	1025.6	0
	700	6	104	20.4	1024.6	0
	1300	2	110	21.2	1022.2	0
	1900	0		19.7	1019.7	0
3	100	1	1	17.2	1018.3	0
	700	4	326	18.3	1017.9	0
	1300	13	11	20.6	1018.5	0
	1900	12	29	17.2	1022.0	0
4	100	11	29	15.8	1024.2	0
	700	13	34	14.5	1027.3	0
	1300	12	27	14.1	1029.7	0
	1900	11	40	12.8	1030.5	0
5	100	11	45	13.8	1030.5	0
	700	12	49	14.8	1030.7	0
	1300	11	46	16.1	1030.7	0
	1900	12	42	15.6	1030.4	0
6	100	12	39	15.5	1029.5	0
	700	10	49	16.0	1028.0	0
	1300	10	30	16.7	1025.9	0
	1900	12	29	16.3	1023.7	0
7	100	11	33	16.3	1020.2	0
	700	10	43	17.7	1017.9	0
	1300	11	80	18.6	1015.6	0
	1900	13	83	17.4	1014.2	0
8	100	13	75	18.0	1009.2	0
	700	14	89	18.6	1000.3	71
	1300	11	210	24.1	988.6	0
	1900	11	316	15.6	997.6	0
9	100	6	291	14.7	1005.1	0
	700	3	275	15.1	1009.3	84
	1300	5	150	19.8	1009.4	0
	1900	6	179	17.4	1008.3	0
10	100	4	1	17.7	1007.8	0
	700	5	1	12.7	1011.1	0
	1300	1	78	16.3	1012.5	0
	1900	6	306	15.5	1016.1	0

**Table 3
Meteorological Data (continued)**

Oct 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	9	329	13.2	1019.1	0
	700	7	7	13.9	1022.7	0
	1300	5	10	14.7	1025.0	0
	1900	5	1	13.5	1026.0	0
12	100	4	24	13.6	1026.9	0
	700	7	17	13.7	1029.0	0
	1300	5	23	15.4	1028.2	0
	1900	5	90	13.9	1027.4	0
13	100	2	196	11.3	1027.0	0
	700	0		12.5	1027.3	0
	1300	3	131	16.8	1025.2	0
	1900	4	182	13.7	1023.5	0
14	100	5	224	14.8	1021.2	0
	700	6	235	15.0	1020.0	0
	1300	6	246	20.9	1016.6	0
	1900	3	244	17.9	1016.2	0
15	100	5	350	18.5	1018.1	0
	700	8	46	16.8	1021.3	0
	1300	5	41	15.7	1022.8	0
	1900	2	92	14.1	1022.1	0
16	100	2	196	11.4	1021.4	0
	700	3	184	15.1	1020.6	0
	1300	4	214	23.2	1018.8	0
	1900	6	200	19.4	1017.5	0
17	100	4	231	18.3	1017.4	0
	700	3	238	17.7	1017.4	0
	1300	2	231	24.5	1016.4	0
	1900	4	206	20.4	1016.0	0
18	100	3	214	18.6	1014.8	0
	700	3	143	18.6	1013.9	0
	1300	6	133	22.9	1010.3	0
	1900	7	152	19.8	1005.2	0
19	100	12	316	15.3	1002.4	0
	700	10	315	10.4	1004.2	15
	1300	6	1	14.7	1003.6	0
	1900	4	285	13.1	1005.9	0
20	100	7	265	9.9	1005.7	0
	700	6	271	10.2	1007.1	0
	1300	7	260	13.9	1006.7	0
	1900	0		11.6	1010.1	0

**Table 3
Meteorological Data (concluded)**

Oct 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	2	242	12.8	1011.4	0
	700	3	303	10.8	1014.3	0
	1300	2	228	16.0	1014.9	0
	1900	4	182	13.3	1016.7	0
22	100	6	206	14.4	1016.9	0
	700	5	224	15.5	1017.5	0
	1300	5	205	22.7	1016.6	0
	1900	6	201	18.3	1017.0	0
23	100	6	200	17.3	1016.5	0
	700	7	187	19.7	1015.6	0
	1300	7	186	24.5	1012.3	0
	1900	7	194	20.3	1010.8	0
24	100	6	233	19.5	1011.6	0
	700	5	273	15.0	1013.5	0
	1300	3	218	19.9	1013.6	0
	1900	3	207	15.2	1015.0	0
25	100	3	244	15.2	1017.3	0
	700	1	237	14.7	1019.5	0
	1300	2	1	20.1	1020.8	0
	1900	3	125	17.7	1022.3	0
26	100	3	93	16.8	1024.1	0
	700	3	75	17.2	1026.9	0
	1300	3	69	19.1	1028.1	0
	1900	4	46	17.2	1029.5	0
27	100	3	49	17.0	1028.9	0
	700	2	81	17.0	1028.6	0
	1300	2	134	18.2	1026.3	0
	1900	2	172	16.4	1024.4	0
28	100	4	231	17.0	1021.0	0
	700	5	233	16.8	1018.3	0
	1300	5	256	21.6	1013.3	0
	1900	6	252	20.0	1012.2	0
29	100	7	11	17.9	1014.3	0
	700	10	13	16.1	1017.0	0
	1300	3	5	15.4	1018.1	0
	1900	2	143	13.3	1017.8	0
30	100	7	155	15.0	1016.2	0
	700	9	170	18.2	1012.1	0
	1300	10	201	25.0	1005.1	0
	1900	6	208	21.4	1005.8	0
31	100	5	258	19.4	1008.3	0
	700	5	303	16.8	1013.4	0
	1300	2	124	20.9	1014.1	0
	1900	4	199	18.1	1014.3	0
		Resultant		Mean	Mean	Total
		1	51	16.9	1017.9	170

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

Oct 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.37	9.9	0.50	10.7	0.69	12.0	68	0.87	7.6
	0700	0.69	5.2	1.06	4.5	1.12	4.6	68	1.20	4.6
	1300	0.95	6.6	1.32	5.9	1.26	5.6	60	1.54	6.0
	1900	0.78	5.4	1.14	5.6	1.10	5.0	64	1.25	5.2
2	0100	0.80	13.5	1.02	13.5	0.99	13.6	82	1.24	8.1
	0700	0.73	12.9	0.99	12.9	0.99	12.0	72	1.21	12.9
	1300	0.67	11.7	0.92	12.2	0.85	12.0	72	1.00	8.6
	1900	0.58	11.7	0.83	7.2	0.86	7.6	84	0.97	7.4
3	0100	0.60	11.2	0.82	11.2	0.89	10.8	68	0.92	11.7
	0700	0.48	11.2	0.76	9.2	0.81	12.0	92	0.86	10.3
	1300	0.68	8.3	1.08	8.3	1.14	8.2	84	1.24	8.3
	1900	1.03	6.1	1.92	6.3	2.07	6.6	56	2.25	6.5
4	0100	1.25	6.5	1.79	7.0	1.94	7.1	54	2.07	7.0
	0700	1.19	7.4	2.17	7.4	2.30	7.6	54	2.36	8.3
	1300	1.28	8.1	1.93	8.3	1.99	8.2	62	2.07	8.3
	1900	1.05	6.3	1.98	9.9	2.08	9.8	68	2.32	8.9
5	0100	1.24	6.8	1.89	7.0	2.00	9.8	68	2.17	11.2
	0700	1.13	6.5	1.98	6.3	2.13	7.1	56	2.31	6.6
	1300	1.31	7.2	2.05	6.8	2.19	7.6	58	2.35	7.6
	1900	1.11	8.9	2.07	8.9	2.31	8.9	76	2.52	8.9
6	0100	1.23	6.0	2.03	9.2	2.13	9.8	72	2.43	7.0
	0700	1.17	6.0	1.70	9.2	1.78	9.8	70	2.10	8.1
	1300	1.11	5.6	1.81	8.1	1.84	9.8	92	2.07	8.1
	1900	1.10	5.7	1.96	8.9	2.18	9.8	72	2.22	8.3
7	0100	1.18	6.5	2.01	9.2	2.05	9.8	72	2.23	8.1
	0700	1.05	9.5	1.71	9.5	1.89	10.8	92	1.97	10.7
	1300	1.33	9.2	1.81	10.3	1.90	9.8	72	2.06	10.7
	1900	1.05	9.9	2.03	10.3	2.08	9.8	94	2.15	5.7
8	0100	1.07	9.9	2.05	9.9	2.09	7.1	68	2.26	6.3
	0700	1.21	8.3	2.21	6.3	2.55	10.8	92	2.69	6.6
	1300	1.41	9.5	2.49	10.3	2.97	9.8	80	3.33	9.9
	1900	1.20	11.2	1.62	11.7	1.67	12.0	72	1.75	11.7
9	0100	0.97	10.7	1.46	10.7	1.39	10.8	100	1.51	10.3
	0700	0.75	9.9	1.12	9.9	1.08	9.8	66	1.22	11.2
	1300	0.57	9.9	0.85	8.6	0.89	9.8	106	1.01	8.1
	1900	0.59	8.3	0.78	11.7	0.69	10.8	64	0.88	9.9
10	0100	0.41	9.2	0.62	9.2	0.66	12.0	58	0.74	8.3
	0700	0.38	9.2	0.61	12.2	0.57	12.0	94	0.75	12.2
	1300	0.32	7.6	0.54	10.7	0.58	10.8	66	0.59	11.2
	1900	0.39	7.6	0.61	9.9	0.56	10.8	60	0.69	10.7

**Table 4
Wave Data (continued)**

Oct 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.59	4.9	0.86	5.0	0.86	4.8	24	1.05	5.2
	0700	0.61	5.2	0.83	5.3	0.79	5.3	34	0.97	5.0
	1300	0.56	5.9	0.87	5.9	0.87	5.9	42	1.18	5.7
	1900	0.48	5.6	0.72	5.7	0.70	5.9	44	1.00	5.5
12	0100	0.29	6.1	0.62	6.8	0.62	6.6	54	0.81	6.8
	0700	0.33	4.8	0.53	5.2	0.41	4.1	58	0.62	5.5
	1300	0.25	3.7	0.45	12.9	0.38	3.9	44	0.51	3.7
	1900	0.27	13.5	0.45	13.5	0.34	13.6	108	0.50	3.9
13	0100	0.18	13.5	0.34	13.5	0.32	13.6	78	0.38	8.1
	0700	0.27	12.9	0.38	13.5	0.35	13.6	62	0.40	8.3
	1300	0.17	8.9	0.34	8.3	0.34	12.0	94	0.38	5.7
	1900	0.28	7.8	0.38	7.4	0.36	8.9	106	0.45	8.6
14	0100	0.19	9.2	0.31	9.2	0.34	8.9	104	0.41	8.9
	0700	0.28	7.4	0.32	8.1	0.33	8.2	106	0.36	9.9
	1300	0.16	9.2	0.28	9.2	0.30	9.8	106	0.31	9.5
	1900	0.29	9.2	0.35	9.2	0.34	8.9	106	0.38	9.5
15	0100	0.21	9.2	0.34	9.2	0.33	8.9	78	0.41	9.2
	0700	0.58	4.4	0.91	4.2	0.82	4.6	40	1.03	4.5
	1300	0.49	5.0	0.74	5.2	0.73	5.3	30	0.86	5.4
	1900	0.48	5.4	0.88	6.3	0.80	6.6	48	1.00	7.2
16	0100	0.42	6.0	0.66	5.5	0.66	6.2	42	0.71	6.5
	0700	0.31	6.0	0.52	6.0	0.52	6.2	48	0.59	6.1
	1300	0.22	8.1	0.42	9.9	0.45	8.9	84		
	1900	0.24	7.6	0.39	9.2	0.40	8.9	82		
17	0100	0.20	8.9	0.38	9.2	0.37	8.9	76		
	0700	0.21	8.6	0.33	8.6	0.35	8.9	104		
	1300	0.22	9.9	0.33	8.6	0.35	8.9	106		
	1900	0.25	9.9	0.40	10.7	0.39	9.8	104		
18	0100	0.31	8.3	0.42	10.7	0.39	8.9	108		
	0700	0.31	11.2	0.45	9.2	0.45	10.8	82		
	1300	0.41	10.3	0.52	10.3	0.48	10.8	78		
	1900	0.38	9.9	0.57	10.3	0.53	9.8	106		
19	0100	0.46	5.9	0.67	6.0	0.65	6.2	122		inoperative
	0700	0.87	5.6	1.17	5.9	1.22	5.9	26		
	1300	0.65	6.3	0.96	7.8	0.93	8.2	60		
	1900	0.34	8.9	0.69	8.9	0.74	8.9	66		
20	0100	0.43	8.1	0.71	9.5	0.87	9.8	66		
	0700	0.35	12.9	0.77	10.3	0.87	12.0	70		
	1300	0.45	9.2	0.78	9.2	0.95	12.0	88		
	1900	0.65	13.5	1.08	10.3	1.24	9.8	66		

**Table 4
Wave Data (concluded)**

Oct 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.82	11.2	1.22	11.2	1.23	10.8	88	inoperative	
	0700	0.62	10.7	1.11	10.7	1.26	10.8	84		
	1300	0.84	11.2	1.16	10.7	1.34	12.0	88		
	1900	0.78	12.2	1.23	12.2	1.27	12.0	60		
22	0100	0.83	12.9	1.18	13.5	1.31	12.0	92		
	0700	0.87	12.2	1.24	12.9	1.45	13.6	72		
	1300	1.25	13.5	1.64	12.9	1.73	13.6	78		
	1900	1.19	14.3	2.04	12.2	2.02	13.6	98		
23	0100	1.26	15.1	2.13	13.5	2.32	13.6	92		
	0700	1.21	16.0	2.23	15.1	2.24	15.7	88	inoperative	
	1300	1.22	16.0	2.39	16.0	2.73	15.7	90		
	1900	1.28	16.0	2.54	16.0	2.52	15.7	82		
24	0100	1.13	15.1	2.38	14.3	2.28	15.7	70		
	0700	1.27	16.0	2.30	16.0	2.24	15.7	80		
	1300	1.10	15.1	1.92	14.3	2.23	13.6	86		
	1900	1.16	14.3	1.49	14.3	1.57	15.7	80		
25	0100	0.90	13.5	1.26	14.3	1.36	13.6	74		
	0700	0.85	13.5	1.12	13.5	1.18	13.6	72		
	1300	0.63	12.9	0.93	12.9	0.99	13.6	70		
	1900	0.66	12.2	0.85	12.2	0.89	12.0	88	inoperative	
26	0100	0.48	11.7	0.75	11.7	0.83	12.0	86		
	0700	0.58	11.7	0.77	12.2	0.81	12.0	74		
	1300	0.48	11.7	0.69	11.7	0.77	12.0	90		
	1900	0.49	11.7	0.77	11.7	0.68	12.0	92		
27	0100	0.32	12.2	0.65	11.2	0.64	10.8	88		
	0700	0.40	11.7	0.60	11.7	0.59	10.8	88		
	1300	0.25	11.7	0.52	11.7	0.55	10.8	102		
	1900	0.29	12.2	0.50	12.9	0.49	12.0	92		
28	0100	0.22	12.9	0.41	12.2	0.45	12.0	66	inoperative	
	0700	0.24	11.2	0.36	10.3	0.39	12.0	70		
	1300	0.18	12.9	0.31	12.2	0.34	10.8	66		
	1900	0.25	12.2	0.30	12.2	0.33	12.0	66		
29	0100	0.24	14.3	0.42	14.3	0.32	13.6	60		
	0700	0.79	5.3	1.11	5.2	1.14	5.3	44		
	1300	0.65	6.6	1.00	6.6	0.99	6.6	48		
	1900	0.50	7.6	0.75	7.6	0.78	7.6	48		
30	0100	0.37	6.0	0.65	7.0	0.57	6.6	38		
	0700	0.44	4.1	0.70	3.8	0.59	3.9	96		
	1300	0.34	4.5	0.54	10.3	0.50	10.8	68		
	1900	0.42	6.0	0.54	10.3	0.54	12.0	72		
31	0100	0.36	6.1	0.47	10.3	0.47	9.8	66		
	0700	0.33	11.2	0.40	10.7	0.44	10.8	104		
	1300	0.37	9.9	0.43	10.3	0.45	9.8	64		
	1900	0.37	9.9	0.45	10.3	0.52	12.0	50		
	Mean	0.65	9.5	1.03	9.8	1.07	10.0	74	1.32	8.0
	Std dev	0.36	3.1	0.63	2.8	0.69	2.8	19	0.76	2.2

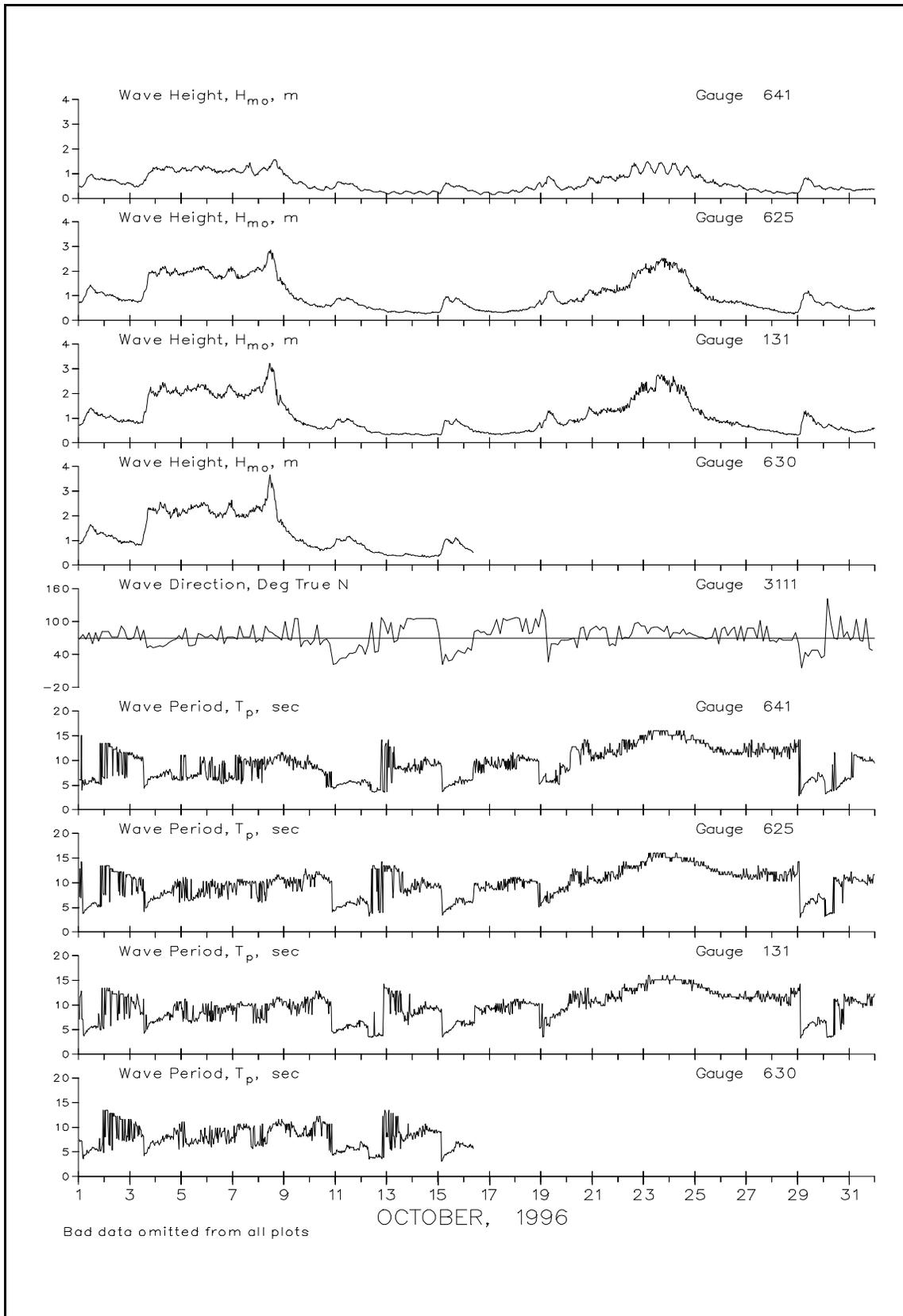


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

OCTOBER 1996																				
Cross Long					Cross Long					Cross Long										
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir			
1	100			inoperative				1300			inoperative				22	100			inoperative	
	700	-5	12	14	135		1900						700							
	1300	-8	13	16	123	12	100						1300							
	1900	-6	11	13	127		700						1900							
2	100	-7	8	11	117		1300					23	100							
	700	-4	1	5	79		1900						700							
	1300	-2	2	4	105	13	100						1300							
	1900	-3	1	4	80		700						1900							
3	100	-2	2	3	98		1300					24	100							
	700	-5	-8	11	14		1900						700							
	1300	-7	20	21	139	14	100						1300							
	1900	-7	27	28	145		700						1900							
4	100	-6	34	35	149		1300					25	100							
	700	-6	29	30	146		1900						700							
	1300	-5	27	28	147	15	100						1300							
	1900	-3	25	25	150		700						1900							
5	100	0	22	22	157		1300					26	100							
	700	-3	19	20	149		1900						700							
	1300	0	16	16	160	16	100						1300							
	1900	-1	23	23	155		700						1900							
6	100	-1	15	15	154		1300					27	100							
	700	-3	16	16	147		1900						700							
	1300	0	8	8	162	17	100						1300							
	1900	-3	23	24	150		700						1900							
7	100	0	16	16	162		1300					28	100							
	700	0	17	17	161		1900						700							
	1300	-4	13	14	141	18	100						1300							
	1900	-2	2	4	96		700						1900							
8	100	-1	0	2	50		1300					29	100							
	700	-3	5	6	122		1900						700							
	1300					19	100						1300							
	1900						700						1900							
9	100						1300					30	100							
	700						1900						700							
	1300						700						1300							
	1900						1900						1900							
10	100						1300						700							
	700						1900						1300							
	1300						700						1900							
	1900						1300						700							
11	100						1900						1300							
	700						1300						1900							

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

**Table 6
Visually Observed Current Data**

Oct 1996											
Day	Pier End				Mid-Surf Zone				Beach		
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	-9	5	10	221	-9	6	10	250	South	30	N
2	-8	14	16	250	6	-20	21	357	South	38	N
3	0	0	0		0	0	0		South	24	N
4	-9	61	62	169	-20	68	71	177	North	75	S
5	-11	44	45	174	-20	68	71	177	North	29	S
6	-13	27	30	187	0	0	0		North	36	S
7	-15	51	53	177	0	16	16	160	North	66	S
8	-22	18	28	250	0	-16	16	340	South	61	N
9	8	21	23	138	0	0	0		North	2	S
10	10	20	22	70	0	0	0		North	8	N
11	0	38	38	160	0	28	28	160	North	38	S
12	-6	32	33	171	0	24	24	160	North	38	S
13	4	7	8	70	3	-8	9	2	South	6	N
14	20	-13	24	36	10	-11	15	22	South	11	N
15	-12	20	23	250	9	12	15	123	North	50	S
16	-2	7	7	174	0	0	0		North	14	S
17	8	-16	17	7	0	-55	55	340	South	38	N
18	5	-22	22	354	-14	-68	69	329	South	27	N
19	20	44	48	136	8	32	33	146	North	29	S
20	4	11	12	138	50	28	57	70	North	26	S
21	7	11	13	129	24	20	31	110	South	5	N
22	12	-27	29	4	42	-47	63	22	South	55	S
23	0	-21	21	340	10	-68	68	349	South	40	N
24	-13	-32	35	318	13	-51	52	354	South	72	N
25	0	-24	24	340	-4	-11	12	321	South	50	N
26	-3	-17	18	329	-10	-10	14	295	South	9	N
27	-11	36	37	177	0	-20	20	340	South	32	N
28	13	-20	24	13	6	-14	15	2	South	14	N
29	-7	44	44	169	-8	51	51	169	North	26	S
30	6	-41	41	349	0	-61	61	340	South	46	N
31	7	8	11	121	0	-29	29	340	South	11	N

KEY:

+cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Oct 1996							
Day	Time	Wave Approach Angle at Pier End deg from True N		Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary		Temp.,C	Density g/cc	Secchi Vis.,m
1	0625	70	40	40	21.1	1.0200	1.2
2	0630	80		189	20.6	1.0194	2.1
3	0615	75		61	20.6	1.0186	2.4
4	0650	45		378	20.0	1.0186	0.3
5	0820	60	40	387	18.1	1.0173	0.3
6	0830	75	50	314	17.8	1.0169	0.3
7	0615	70	40	276	18.9	1.0196	0.0
8	0610	90		367	19.2	1.0196	0.0
9	0615	50	25	73	18.9	1.0214	0.3
10	0550	70	30	37	18.9	1.0215	0.3
11	0600	35		67	18.9	1.0215	0.6
12	0850	40		40	17.5	1.0204	1.8
13	0920	70	100	11	17.5	1.0187	1.5
14	0900	110		3	18.6	1.0214	1.2
15	0625	40		56	18.6	1.0213	1.5
16	0610	60	100	49	17.8	1.0193	1.5
17	0610	100		50	18.9	1.0225	1.2
18	0615	90		50	18.9	1.0224	2.7
19	0830	45		72	18.3	1.0223	0.3
20	0830	75		56	17.5	1.0228	0.6
21	0630	70		186	17.5	1.0225	1.2
22	0720	70		165	17.8	1.0226	1.2
23	0605	95		332	18.1	1.0225	0.0
24	0615	80		323	18.3	1.0230	0.0
25	0645	60		101	18.1	1.0223	0.6
26	0820	90		61	18.6	1.0222	1.2
27	0845	80	105	43	18.5	1.0181	1.5
28	0710	100		3	18.1	1.0199	1.8
29	0650	40		73	18.1	1.0214	0.9
30	0715	105		67	17.8	1.0202	2.1
31	0700	90		40	18.3	1.0227	0.9

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

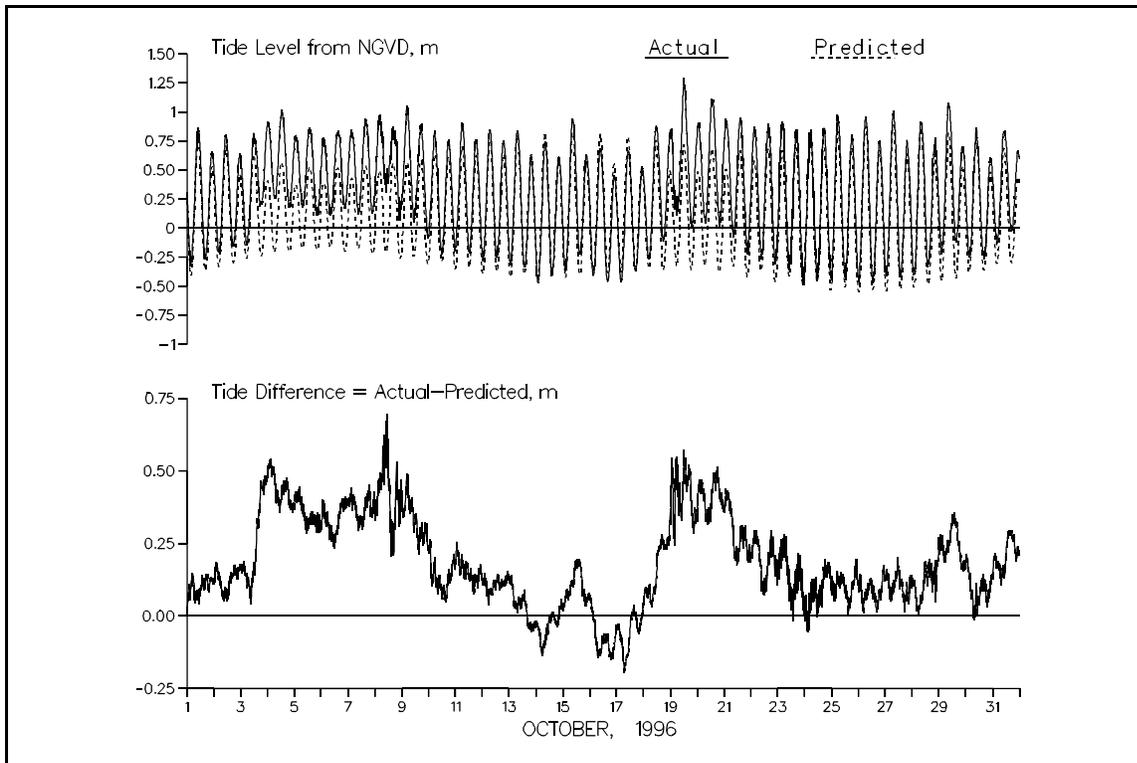


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

OCT 1996 Tide Levels															
Day	High		Day	Low		Mean	Range	Day	High		Day	Low		Mean	Range
	Time	m		Time	m				m	m		Time	m		
1	1000	0.86	1	0318	-0.32	0.27	1.19	16	2206	0.45	16	1606	-0.47	-0.01	0.92
1	2236	0.66	1	1630	-0.27	0.20	0.93	17	1036	0.67	17	0400	-0.46	0.10	1.13
2	1042	0.80	2	0442	-0.21	0.29	1.01	17	2236	0.53	17	1712	-0.37	0.08	0.90
2	2312	0.64	2	1724	-0.16	0.24	0.80	18	1124	0.88	18	0436	-0.27	0.31	1.15
3	1142	0.82	3	0542	-0.15	0.35	0.97	19	0130	0.86	18	1748	-0.12	0.37	0.98
4	0030	0.92	3	1712	0.19	0.55	0.73	19	1212	1.29	19	0542	0.11	0.63	1.18
4	1242	1.02	4	0642	0.25	0.62	0.77	20	0136	0.91	19	1912	-0.01	0.47	0.91
5	0100	0.80	4	1954	0.17	0.50	0.63	20	1318	1.12	20	0718	0.04	0.58	1.08
5	1336	0.86	5	0712	0.17	0.52	0.69	21	0154	0.94	20	1954	0.02	0.49	0.92
6	0218	0.78	5	1948	0.11	0.44	0.67	21	1506	0.95	21	0818	-0.09	0.43	1.04
6	1542	0.84	6	0818	0.10	0.48	0.74	22	0312	0.87	21	2100	-0.22	0.34	1.09
7	0242	0.85	6	2124	0.17	0.51	0.68	22	1548	0.89	22	0942	-0.27	0.32	1.16
7	1548	0.94	7	0936	0.12	0.54	0.82	23	0354	0.92	22	2118	-0.31	0.32	1.23
8	0448	0.98	7	2124	0.12	0.55	0.86	23	1636	0.85	23	1024	-0.36	0.25	1.21
8	1612	0.88	8	1024	0.31	0.60	0.57	24	0536	0.85	23	2236	-0.48	0.18	1.33
9	0500	1.05	8	2200	0.06	0.54	0.99	24	1706	0.86	24	1054	-0.46	0.22	1.32
9	1736	0.89	9	1106	0.05	0.47	0.85	25	0536	0.98	25	0000	-0.45	0.26	1.43
10	0536	0.84	9	2324	-0.09	0.34	0.92	25	1830	0.80	25	1200	-0.42	0.18	1.23
10	1806	0.76	10	1212	-0.22	0.26	0.98	26	0654	0.96	26	0030	-0.47	0.26	1.43
11	0548	0.91	10	2354	-0.20	0.36	1.11	26	1900	0.75	26	1300	-0.47	0.16	1.23
11	1824	0.76	11	1218	-0.22	0.28	0.98	27	0712	1.01	27	0054	-0.41	0.29	1.42
12	0630	0.85	12	0036	-0.29	0.29	1.14	27	1936	0.76	27	1354	-0.42	0.16	1.18
12	1900	0.75	12	1300	-0.26	0.25	1.01	28	0742	0.92	28	0130	-0.40	0.26	1.32
13	0712	0.84	13	0112	-0.31	0.26	1.15	28	2048	0.78	28	1348	-0.34	0.21	1.11
13	1930	0.61	13	1418	-0.34	0.12	0.94	29	0836	1.08	29	0236	-0.22	0.44	1.30
14	0800	0.74	14	0142	-0.48	0.13	1.22	29	2054	0.70	29	1530	-0.12	0.30	0.83
14	2018	0.61	14	1400	-0.41	0.11	1.02	30	0918	0.87	30	0306	-0.25	0.27	1.12
15	0848	0.94	15	0212	-0.38	0.29	1.32	30	2200	0.60	30	1636	-0.26	0.17	0.87
15	2042	0.63	15	1454	-0.23	0.20	0.86	31	1024	0.83	31	0348	-0.15	0.37	0.98
16	0906	0.69	16	0312	-0.41	0.13	1.10								

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in September 1996 and the survey(s) in October 1996 on profile line 188, located 517 m south of the pier.

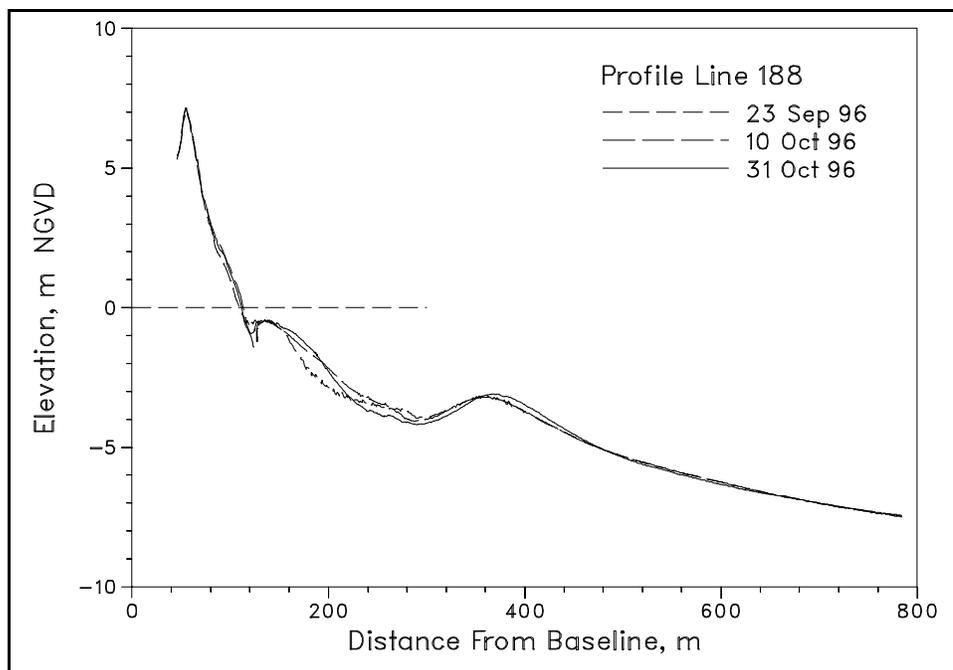


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1996. Cross-hatched areas indicate changes to the annual envelope which occurred in October.

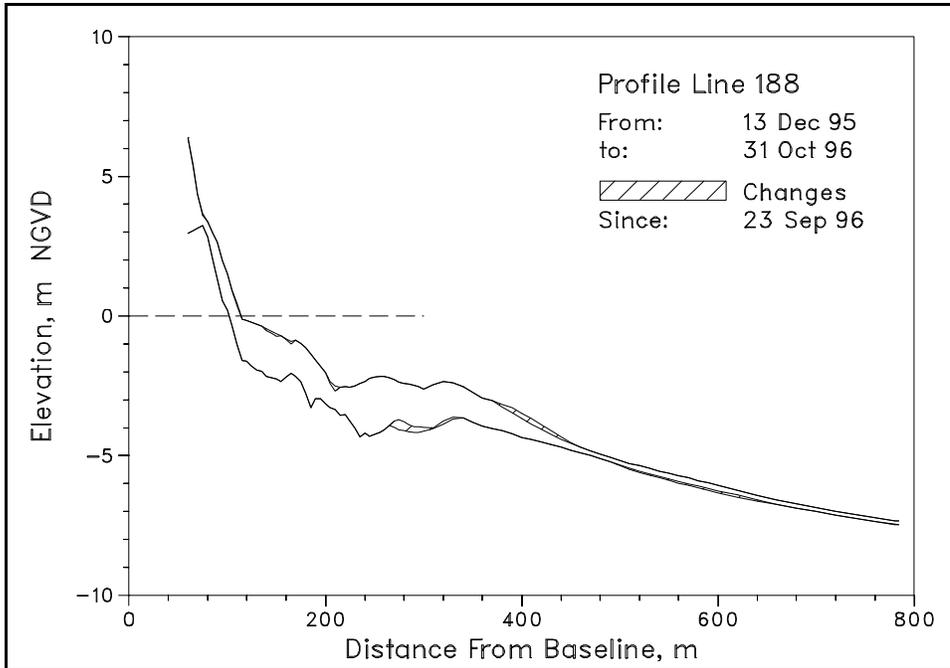
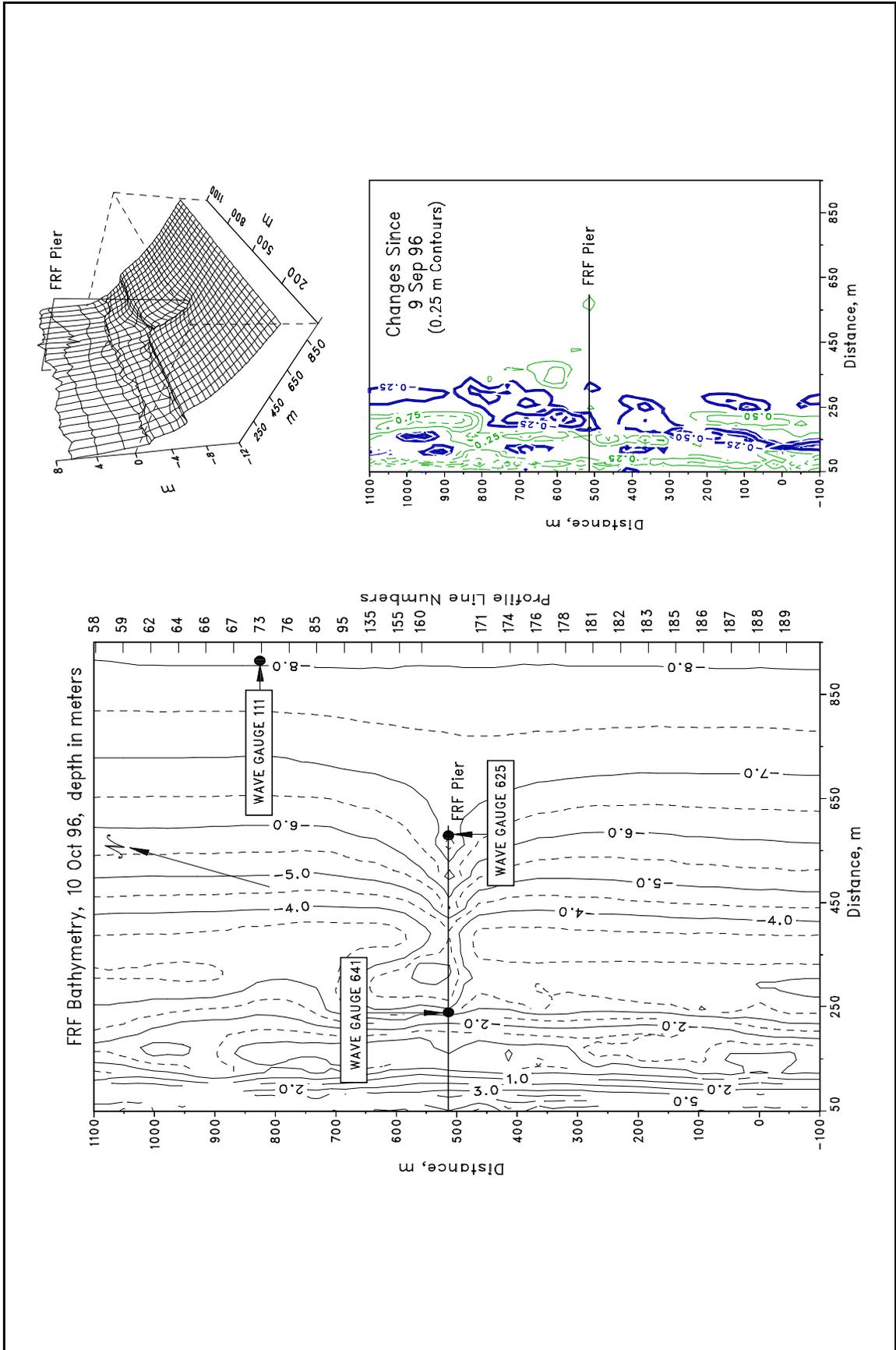


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 10 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
4 Oct (0434)	8 Oct (1708)
22 Oct (1900)	24 Oct (1516)

B. Storm Synopsis.

4-8 Oct Northeasterly winds were produced by a high pressure system over New England. Winds intensified as a low pressure system began moving up the coast by 7 October. Maximum onshore winds (NE) reached 21 m/s at 1108 EST on 8 October. The minimum atmospheric pressure was 990 mb. The maximum H_{mo} , at gauge 625, reached 2.9 m ($T_p=10.2$ s) at 1142 EST on 8 October. There was 71 mm of precipitation.

22-24 Oct Southeasterly winds were funneled between a low pressure system over New England and a high pressure system southeast of Cape Hatteras. Maximum onshore winds (NE) reached 8 m/s at 1816 EST on 23 October as the front moved offshore. The maximum H_{mo} , at gauge 625, reached 2.5 m ($T_p=16.0$ s) at 1708 EST on 23 October. Atmospheric pressure was undisturbed. There was no precipitation.